

CLAIMS

What is claimed is:

1 1. A filter element having a ring of filter media defining a central cavity and
2 circumscribing a central axis, said ring of filter media having a first end and a second end;
3 first and second end caps fixed to said first and second ends, respectively, of said filter
4 media, the second end cap having an annular end cap portion sealingly bonded to the
5 second end of said filter media, wherein the second end cap has a valve-actuating portion,
6 including an axially-extending cylindrical portion connected to the annular end cap
7 portion and circumscribing the inner diameter of said annular end cap portion and an
8 annular base connected to the cylindrical portion and extending radially inward from said
9 cylindrical portion to define a first central opening, the base having a surface facing
10 inwardly toward the first end, and a plurality of keys supported by and extending away
11 from said valve-actuating portion in an axially inward direction from said base toward said
12 first end cap, each of said keys having a free engaging portion positioned radially inward
13 to an inner surface of said cylindrical portion and axially spaced away from said annular
14 base.

1 2. The filter element as in claim 1, wherein each of said keys includes a step
2 including a first edge portion terminating axially a first distance from said annular base
3 and radially inward a first distance from said cylindrical portion, and a second edge
4 portion terminating axially a second distance from said annular base and radially inward
5 a second distance from said cylindrical portion.

1 3. The filter element as in claim 1, wherein said keys are each thin and flat strips
2 connected to the valve actuating portion.

1 4. The filter element as in claim 1, wherein each of said keys is connected directly to
2 both the cylindrical portion and said annular base, and the keys extend radially inward
3 from said cylindrical portion to terminate radially outward from the first central opening,
4 and extend axially away from said annular base.

1 5. The filter element as in claim 1, wherein said annular end cap portion, cylindrical
2 portion, base and said keys are unitary, in one piece.

1 6. The filter element as in claim 1, further including a key device for defining said
2 keys, said key device being supported against said annular base as a separate component
3 from the cylindrical portion, and is sealingly attached thereto.

1 7. A filter element comprising:

2 a ring of filter media defining a central cavity and circumscribing a central axis,
3 said ring of filter media having a first end and a second end;

4 first and second end caps fixed to said first and second ends, respectively, of said
5 filter media, the second end cap having an annular end cap portion sealingly bonded to
6 the second end of said filter media and a valve-actuating portion, the valve-actuating
7 portion including: i) a cylindrical portion connected at one end to and circumscribing the
8 inner diameter of said annular end cap portion and extending inward into the central
9 cavity from the second end cap toward the first end cap and terminating prior to the first
10 end cap; ii) an annular base connected to the cylindrical portion and extending radially
11 inward from said cylindrical portion to define a first central opening which can receive a

12 pipe, the base having a surface facing inwardly toward the first end; and iii) a plurality of
13 discrete keys supported at one end by the surface of the base and projecting axially
14 outward from the surface of said annular base toward the said first end cap and
15 terminating prior to the first end cap, the keys having a free engaging end radially inward
16 of an inner surface of said cylindrical portion and axially spaced outwardly from said
17 annular base.

1 8. The filter element as in claim 7, wherein said first central opening is internal to
2 the central cavity.

1 9. The filter element as in claim 8, wherein said free engaging end of each key is an
2 edge.

1 10. The filter element as in claim 7, wherein the edges of the keys face the annular
2 end cap.

1 11. The filter element as in claim 7, wherein the free engaging ends of the keys are
2 internal the central cavity and face toward the first end cap.

1 12. The filter element as in claim 7, wherein the keys are fixed to the annular base.

1 13. The filter element as in claim 12, wherein the keys are unitary with the base.

1 14. The filter element as in claim 7, wherein the keys have a width projecting radially
2 inward from the cylindrical portion to an inner edge in bounding relation to the first
3 central opening.

1 15. The filter element as in claim 7, wherein the keys are fixed to the cylindrical
2 portion.

1 16. The filter element as in claim 7, wherein the cylindrical portion is unitary with the
2 annular end cap portion.

1 17. The filter element as in claim 7, wherein said keys are axially elongated.

1 18. A filter element comprising:
2 a ring of filter media defining a central cavity and circumscribing a central axis,
3 said ring of filter media having a first end and a second end;
4 first and second end caps fixed to said first and second ends, respectively, of said
5 filter media, the second end cap having an annular end cap portion sealingly bonded to
6 the second end of said filter media and a valve-actuating portion including i) a cylindrical
7 portion connected at one end to and circumscribing the inner diameter of said annular
8 end cap portion and extending inward into the central cavity from the second end cap
9 toward the first end cap and terminating prior to the first end cap, ii) an annular base
10 connected to the cylindrical portion and extending radially inward from said cylindrical
11 portion to define a first central opening which can receive a pipe, the base having a
12 surface facing inwardly toward the first end; and iii) a plurality of discrete keys supported
13 by the surface of the base of the cylindrical portion in outwardly bounding relation to the
14 first central opening, the keys each having a free engaging end facing the first end cap,
15 radially inward of an inner surface of said cylindrical portion and axially spaced
16 outwardly from said annular base.

1 19. The filter element as in claim 18, wherein said first central opening is internal to
2 the central cavity.

1 20. The filter element as in claim 18, wherein said free engaging end of each key is an
2 edge.

1 21. The filter element as in claim 18, wherein the free engaging ends of the keys are
2 internal to the central cavity and face toward the first end cap.

1 22. The filter element as in claim 18, wherein the keys are fixed to the annular base.

1 23. The filter element as in claim 18, wherein the keys are unitary with the cylindrical
2 portion.

1 24. The filter element as in claim 18, wherein the cylindrical portion is unitary with
2 the annular end cap portion.

1 25. The filter element as in claim 18, wherein said keys are axially elongated.

1 26. The filter element as in claim 18, wherein said first end cap is annular and
2 imperforate.

1 27. The filter element as in claim 18, wherein the cylindrical portion and annular base
2 are imperforate.

1 28. The filter element as in claim 18, wherein an end wall encloses one end of the
2 cylindrical portion to define a cup-shaped valve structure receiving cavity.

1 29. A filter assembly including a filter element having a ring of filter media defining a
2 central cavity and circumscribing a central axis, said ring of filter media having a first
3 end and a second end; first and second end caps fixed to said first and second ends,
4 respectively, of said filter media, the second end cap having an annular end cap portion
5 sealingly bonded to the second end of said filter media, wherein the second end cap has a
6 valve-actuating portion, including an axially-extending cylindrical portion connected to
7 the annular end cap portion and circumscribing the inner diameter of said annular end cap
8 portion and an annular base connected to the cylindrical portion and extending radially
9 inward from said cylindrical portion to define a first central opening which can receive
10 a pipe, and a plurality of keys projecting from said valve-actuating portion, each of said
11 keys having an engaging portion radially inward spaced from said cylindrical portion and
12 radially spaced away from said annular base,

13 and a cylindrical housing formed of mateable housing portions defining a filter
14 cavity in the housing, and a cylindrical pipe in the housing extending axially from a distal
15 end toward one end of the housing, the pipe including a central passage and an opening
16 along the length of the pipe providing fluid communication with the filter cavity, and an
17 outwardly-opening groove extending circumferentially around the exterior of the pipe;

18 a latch device normally moveable axially along the pipe, said latch device having
19 a plurality of discrete fingers closely surrounding the pipe and engageable with the
20 groove in the pipe to prevent the latch device from moving axially along the pipe, the
21 latch device further having an annular sleeve spaced radially outward from the fingers,
22 which when engage, moves the fingers out of engagement with the groove to allow the
23 latch device to move axially along the pipe,

24 a valve device also moveable axially along the pipe, the valve device having a
25 valve sleeve closely surrounding the pipe which normally covers the flow opening in the
26 pipe to prevent flow therethrough, and an annular base extending radially outward from
27 the valve sleeve and having a plurality of radially-projecting tabs defining a plurality of
28 slots,

29 a biasing device urging the latch device and valve device toward the distal end of
30 the pipe,

31 the pipe received in the central opening of the filter element, a portion of at least
32 some of keys projecting through the slots in the base of the valve device and engaging the
33 sleeve of the latch device, and another portion of at least some of said keys engaging the
34 valve device to maintain the flow opening in the pipe in an open condition.

1 30. A filter assembly including a cylindrical housing, a lid removeably connectable to
2 an open end of the housing and defining a filter cavity in the housing, and a cylindrical
3 standpipe in the housing extending axially from a distal end toward the open end of the
4 housing, the standpipe including a central passage and an opening along the length of the
5 standpipe providing fluid communication with the filter cavity, and an outwardly-opening
6 groove extending circumferentially around the exterior of the standpipe,

7 a latch device normally moveable along the standpipe, said latch device having a
8 plurality of discrete fingers closely surrounding the standpipe and engageable with the
9 groove in the standpipe to prevent the latch device from moving axially along the
10 standpipe, the latch device further having an annular sleeve spaced radially outward from
11 said fingers which when engaged moves the fingers out of engagement with the groove to
12 allow the latch device to move axially along the standpipe,

13 a valve device also moveable axially along the standpipe, the valve device having
14 a valve sleeve closely surrounding the standpipe which normally covers the flow opening

15 in the standpipe to prevent flow therethrough, and an annular base extending radially
16 outward from the sleeve and having a plurality of radially-projecting tabs defining a
17 plurality of slots,

18 a biasing device urging the latch device and valve device toward the distal end of
19 the standpipe, and

20 a filter element disposed within the housing, the filter element including a ring of
21 filter media defining a central cavity and circumscribing a central axis, said ring of media
22 having a first end and a second end;

23 first and second circular end caps at said first and second ends, respectively, of
24 said filter media, the second end cap having an annular end cap portion fixed to the
25 second end of said filter media, the second end cap further having a valve-actuating
26 portion, the valve-actuating portion including an axially-extending cylindrical portion
27 unitary with and bounding the inner diameter of said annular end cap portion, and an
28 annular base connected to the cylindrical portion and projecting radially inward from said
29 cylindrical portion to define a first central opening, the central opening receiving the
30 standpipe, and a plurality of keys located internally of the cylindrical portion, a portion of
31 at least some of said keys projecting through the slots in the base of the valve device and
32 engaging the sleeve of the latch device, and another portion of at least some of said keys
33 engaging the valve device to maintain the flow opening in the standpipe in an open
34 condition.

1 31. The filter assembly as in claim 30, wherein said keys are each thin and flat strips.

1 32. The filter assembly as in claim 30, wherein each of said keys has a first edge
2 connected to the cylindrical portion and a second edge connected to said annular base,

3 and the keys extend radially inward from said cylindrical portion to terminate radially
4 outward from the first central opening and extend radially away from said annular base.

1 33. The filter assembly as in claim 30, wherein said keys extend from said annular
2 base in an axial outward direction from said filter ring and terminate prior to said annular
3 end cap portion.

1 34. The filter assembly as in claim 30, wherein said keys extend from said annular
2 base in an axial outward direction into said filter ring.

1 35. The filter assembly as in claim 30, wherein said keys are connected to and project
2 axially away from said annular base.

1 36. The filter assembly as in claim 30, wherein said keys are connected to and project
2 axially inward from said cylindrical portion.

1 37. The filter assembly as in claim 30, wherein said annular end cap portion defines a
2 second central opening co-axial with and radially larger than first said opening, and said
3 keys extend radially-inward of the second central opening.

1 38. The filter assembly as in claim 30, wherein said annular end cap portion,
2 cylindrical portion, annular base and said keys are unitary, in one piece.

1 39. A filter assembly including a housing formed from a pair of mateable housing
2 portions defining an interior cavity, and an inlet pipe in the housing extending axially
3 toward one end of the housing, the inlet pipe including a central passage and an opening

4 along the length of the pipe providing fluid communication with the interior cavity, and
5 an outwardly-opening groove extending circumferentially around the exterior of the inlet
6 pipe,

7 a latch device normally moveable axially along the pipe, said latch device having
8 a plurality of discrete fingers closely surrounding the pipe and engageable with the
9 groove in the pipe to prevent the latch device from moving axially along the pipe, the
10 latch device further having an annular sleeve, which when engaged, moves the fingers
11 out of engagement with the groove to allow the latch device to move axially along the
12 pipe,

13 a valve device also moveable axially along the pipe, the valve device having a
14 valve sleeve closely surrounding the pipe which normally covers the flow opening in the
15 pipe to prevent flow therethrough, and an annular base extending radially outward from
16 the sleeve and having a plurality of radially-projecting tabs defining a plurality of slots
17 around the periphery of the base,

18 a biasing device urging the latch device and valve device toward the distal end of
19 the pipe; and

20 a filter element disposed within the housing, the filter element including a ring of
21 filter media defining a central cavity and circumscribing a central axis, said ring of filter
22 media having a first end and a second end;

23 first and second end caps at said first and second ends, respectively, of said filter
24 media, the second end cap having an annular end cap portion fixed to the second end of
25 said filter media, the second end cap further having a valve-actuating portion, the valve-
26 actuating portion including an axially-extending cylindrical portion connected to and
27 bounding the inner diameter of said annular end cap portion, and an annular base
28 connected to the cylindrical portion and projecting radially inward from said cylindrical
29 portion to define a central opening, the central opening receiving the pipe to

30 communicate flow with the central cavity of the cylindrical portion, at least some of said
31 keys projecting through the slots in the base of the valve device and engaging the sleeve
32 of the latch device, and at least some of said keys also engaging the base of the valve
33 device to maintain the flow opening in the pipe in an open position.

1 40. The filter assembly as in claim 39, wherein said keys are each thin and flat strips.

1 41. The filter assembly as in claim 39, wherein said keys each has a first edge
2 connected to the cylindrical portion and a second edge connected to said annular base,
3 and the keys extend radially inward from said cylindrical portion to terminate radially
4 outward from the first central opening and extend axially away from said annular base.

1 42. The filter assembly as in claim 39, wherein said keys extend from said annular
2 base in an axial outward direction from said filter ring and terminate prior to said annular
3 end cap portion.

1 43. The filter assembly as in claim 39, wherein said keys extend from said annular
2 base in an axial inward direction into said filter ring.

1 44. The filter assembly as in claim 39, wherein said keys are connected to and project
2 axially away from said annular base.

1 45. The filter assembly as in claim 39, wherein said keys are connected to and project
2 radially inward from said cylindrical portion.

1 46. The filter assembly as in claim 39, wherein said annular portion defines a second
2 central opening, co-axial with and radially larger than said first opening, and said keys
3 extend radially inward of the second central opening.

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1 47. The filter assembly as in claim 39, wherein said annular end cap portion,
2 cylindrical portion, annular base and said keys are unitary, in one piece.

1 48. The filter assembly as in claim 39, wherein said cylindrical portion is enclosed at
2 an end opposite from the keys by an end wall.